

The morphology of preimaginal stages of *Agoliinus satyrus* (Reitter, 1892) (Coleoptera: Aphodiidae: Aphodiini), with notes on reproductive biology

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The morphology of preimaginal stages of *Agoliinus satyrus* (Reitter, 1892) (Coleoptera: Aphodiidae: Aphodiini), with notes on reproductive biology. - *Agoliinus satyrus* (Reitter, 1892), a rare mountain species with a Central-Southern and Eastern European distribution, is examined under laboratory conditions. Descriptions of the morphology of egg and 3rd instar larva of *A. satyrus* are presented here, and data on biological cycle are discussed.

Keywords: Dung beetles - Valle d'Aosta - Italy - morphology - reproductive aspects - egg - larva.

INTRODUCTION

During the last decades, preimaginal stages of Aphodiini were widely studied (Barbero & Palestini, 1995; Frolov, 1996; Krell, 1997; Palestini *et al.*, 1999; Frolov & Ivanov, 2001), nevertheless knowledge of larval morphology remains still poor, due chiefly to the great number of genera – more than 170 – assigned to the tribe (Dellacasa *et al.*, 2001).

Aim of the present paper is to furnish information on larval morphology in the holarctic genus *Agoliinus* (Schmidt, 1913), which comprises about twenty species (Dellacasa, 1987).

Three *Agoliinus* species are surely known from Italy [*A. piceus* (Gyllenhal, 1808), *A. ragusai* (Reitter, 1892) and *A. satyrus* (Reitter, 1892)], while records of presence of a fourth one [*A. nemoralis* (Erichson, 1848)] must be verified (Dellacasa *et al.*, 2001; Dellacasa & Dellacasa, 2006).

A. satyrus is an uncommon coprophagous (quite euryphagous) species, characterized by a Central-Southern and Eastern European distribution. It spreads mainly from 1,500 to 2,500 m, and rarefies to higher quote (Dellacasa & Dellacasa, 2006). This stenotopic species is typical of exposed pastures, but can be found also in sheltered xeric pastures (as oligotopic species). It has late spring, summer and fall phenology (Dellacasa & Dellacasa, 2006).

We observed some phases of reproductive biology of *A. satyrus*, and here provided description and illustrations of its egg and 3rd instar larva.

MATERIAL AND METHODS

During the years 2005-06, within the Community Project *Interreg IIIA "Cogeva-Vahsa"*, we collected 183 adults specimens of *A. satyrus* in various localities (Tab. I) of Val Ferret (Courmayeur ZPS IT 1204030) and Val Veny (SIC IT 1204010 Monte Bianco) in Valle d'Aosta, Italy along the whole summer (Fig. 1).

On August 19th 2007, 30 adults of *A. satyrus* were collected on from Lac Malatrà (Val Ferret, Valle d'Aosta, Italy) and reared in plastic cointainers (22 cm diameter) for 25 days at least, feeding them with cow dung. The rearing follows methods already employed in our laboratory (Palestrini *et al.*, 1992). Eggs (N = 15) and larvae (N = 8) were then killed, fixed and preserved in ethanol 95°.

After soaking the larvae in 5% KOH solution, the relevant parts were dissected, mounted on slides and observed through a stereoscopic microscope Leica MZ8 (Leica Microsystems AG, Wetzler, Germany) for the study of the minute morphological structures.

Measures of each anatomical piece were obtained from images captured by a digital camera Leica DFC320 connected to a stereoscopic system Leica Z16Apo (Leica Microsystems AG, Wetzler, Germany). All the measurements were made with the software LAS (Leica Application Suite) v2.5.0, and were chosen according to Barbero *et al.* (2001).

TABLE 1

		Locality	N	Quote (m)
Val Ferret	June	Pont Pailler	4	1507
	July	Lavachey	1	1642
		Greuvettaz	12	1760
		Arp-Nouva	26	1790
	August	Greuvettaz	11	1760
		Secheron	8	1873
		Pré-de-Bard	10	2050
		Armina	74	2245
	September	Plan Pincieux	2	1610
		Greuvettaz	5	2097
Val Veny		Bonatti	18	2111
		Malatrà	6	2274
	August	Gabba	2	1592
	September	Lex-Blanche	1	1965
		Rifugio Elisabetta	3	2160

RESULTS AND DISCUSSION

DESCRIPTION OF EGG: (Fig. 2). Length 0.88 - 1.92 [2.64] mm, width 0.87 - 1.80 [2.37] mm (N = 15).

Egg whitish, regularly ovalar at deposition, then irregular close to the hatching of the 1st instar larva.

DESCRIPTION OF THIRD INSTAR LARVA: (Figs 3-5). Body outer length 6.64-4.02; body inner length 1.82-3.16; head side length 0.68-1.07; head side width 0.44-0.55;

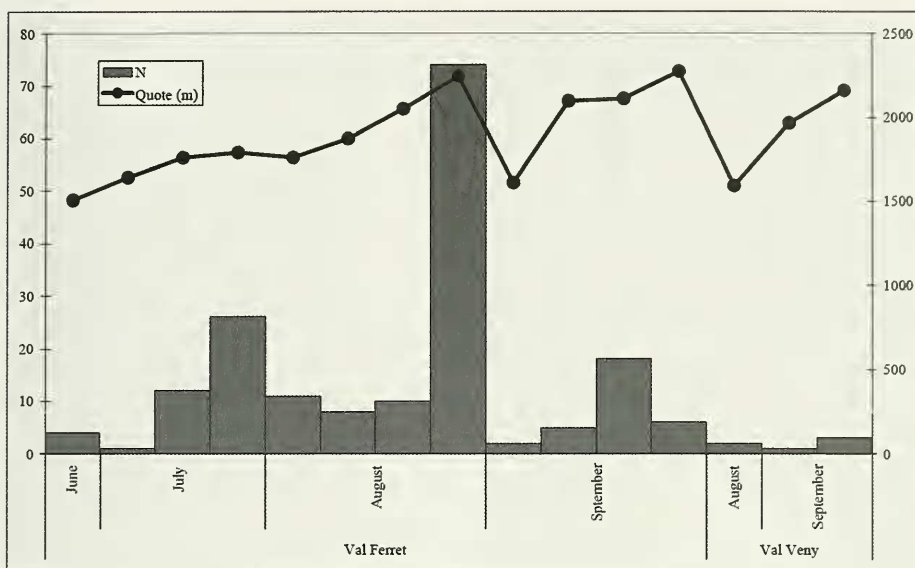


FIG. 1. Histogram of the number of individuals of *A. satyrus* ($N_{tot} = 183$) collected in Val Ferret and Val Veny in the years 2005-06. Left Y-axis: N = number of individuals collected in each locality. Right Y-axis: Quote values. Each locality in Tab. 1 is reported in the present graph.

thorax I 0.60-0.96; thorax II 0.62-1.06; abdomen 0.73-1.11; IX abdominal segment width 0.37-0.76; X abdominal segment length I 0.24-0.55; X abdominal segment length II 0.19-0.34; X abdominal segment length III 0.23-0.46 ($N = 8$).

Melolonthoid larva (3A), greatly bent, whitish, the three thoracic segments all of equal size, while VI, VII and VIII abdominal segments are larger. Pubescence of abdomen yellowish-ochreous, dorsally minute setae mixed up with far longer ones, medially arranged along transversal bands; ventral side, pubescence usually scattered. Spiracles clearly visible, carrying little sclerotized and small cribose plate.

Head (Fig. 4B). Length 0.78 mm, width 1.07 mm; clypeus base 0.57 mm, apex 0.34 mm, length 0.15 mm. Cephalic capsule well-sclerotized, ochreous, transversal, with a short, very deep and sclerotized epicranial suture. Two not-sclerotized diverging frontal sutures lead off the epicranial suture, sinuate at two thirds, and extended to insertion of antenna. Distinct separation between cranial capsule and clypeus. Two pairs of fore long setae, the inner one is behind the margin; three long antero-lateral setae around the antennal base, and minute, irregular pubescence along the capsule surface. Clypeus transversal and subtrapezoidal, with distinct less-sclerotized and reduced anteclypeus and well-sclerotized, yellowish postclypeus. Two pairs of clypeal setae, one lateral, long, placed near the line between ante and post-clypeus, the smaller other placed innerly.

Epipharynx (Fig. 4A). Length 0.25 mm; width 0.32 mm and 0.23 mm. Cordiform, slightly trilobate, little notched, bearing evident, well-sclerotized and deep clithra. Ventral side: haptomerum carrying two placoid sensilla, acropariae 4+4;



FIG. 2

(A) Beginning egg. (B) Mature egg. (C) Adult. Scale bar length = 1 mm.

acanthopariae 2+1, the basal one smaller; large gymnopariae; curvilinear dexiophobae and laeophobae; circularly arranged marked prophobae, with small series of phobae on left pedial area; hind epitorma merged at center, fore epitorma elongate, longitudinal, slightly expanded at apex; not much developed and asymmetrical laeotorma and dexiotorma, the former one a little more pronounced. Transversal and very thick mesophobae.

Labrum (Fig. 4A). Length 0.19 mm; width 0.32 mm and 0.28 mm. Anterior margin trilobate, with little developed lobes. Pubescence: four fore central setae, two antero-lateral setae, four large setae on a median line, and – basally – two small setae.

Mandibles (Fig. 4C). Length 0.42; width 0.45; space between mandibles: 0.21 mm. Sickie-shaped, asymmetrical. Scissorial area of left mandible with distal teeth little pronounced, molar area concave in the middle, constituted by an anterior part projecting ahead, and two lateral areas, the left one more developed and extended. Tuft of setae on side of molar area. Right mandible with little scissure surrounding a small tooth-like process in scissorial area; protruding molar area with a line of setae superiorly and laterally, and two setae on ventral side.

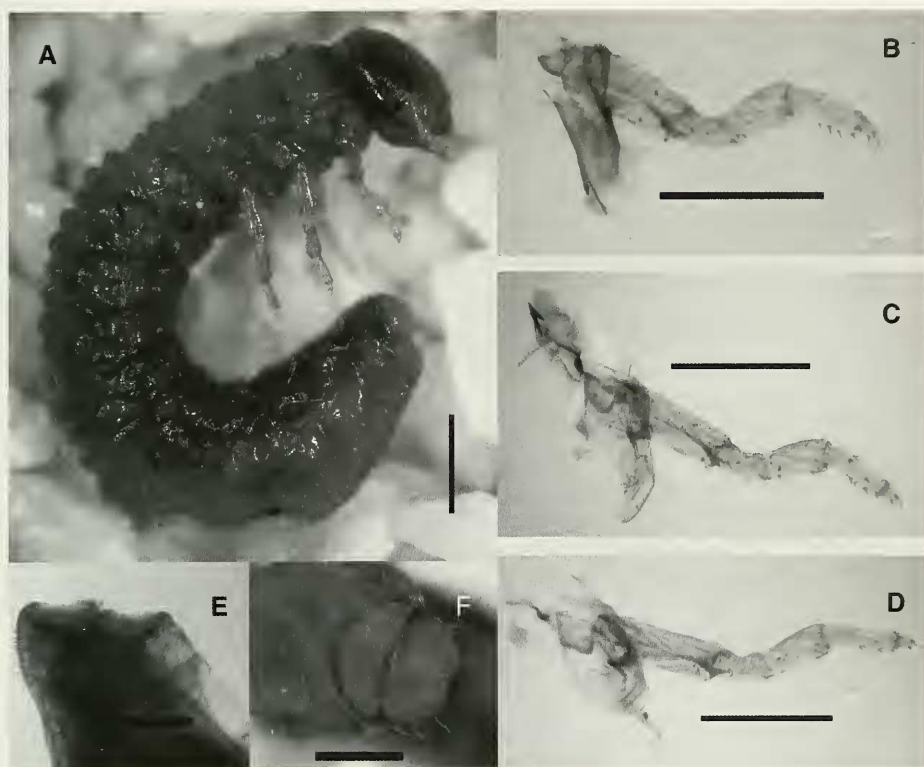


FIG. 3

(A) Larva, habitus, side view. (B) Right fore leg. (C) Right middle leg. (D) Right hind leg. (E) Raster, side view. (F) X Abdominal segment. Scale bar length = 0.5 mm.

Maxillae (Fig. 4D). Galea length 0.19; Lacinia length 0.26; Palpifer length 0.05, width 0.08; Palpus length 0.27. Palpifer clearly evident, little sclerotized, carrying 4-segmented maxillary palpi, segment 1 transversal and shorter than segment 2, with a single seta; segment 2 scarcely more sclerotized, with two setae, and shorter than segment 3, that is elongate, subcylindrical, carrying two setae; segment 4 elongate and tapered at apex; apex truncated, with microsensilla and 2 setae at least (one large and one smaller). At base of palpifer there are two long setae fixed up to 11 minute teeth, some arranged along an oblique line. Lacinia elongate, not much sclerotized, mucronated at apex, with 9-10 setae; galea mucronated with 5 setae.

Hypopharynx (Fig. 4E). Length 0.26 mm; width 0.17 mm and 0.27 mm. Palpus length 0.08 mm. Labial palpi with two poorly sclerotized segments, segment 1 expanded, segment 2 wholly not-sclerotized, truncated, tapered at apex, with sensilla; stipes evident; ligula large; elongate maxillulae. Maxillae: glossa carrying 4 macrosensilla, transversal line of setae; asymmetrical oncily, the right one horizontal, Y-shaped, more expanded and bilobed, the left one H-shaped, reduced and longitudinal.

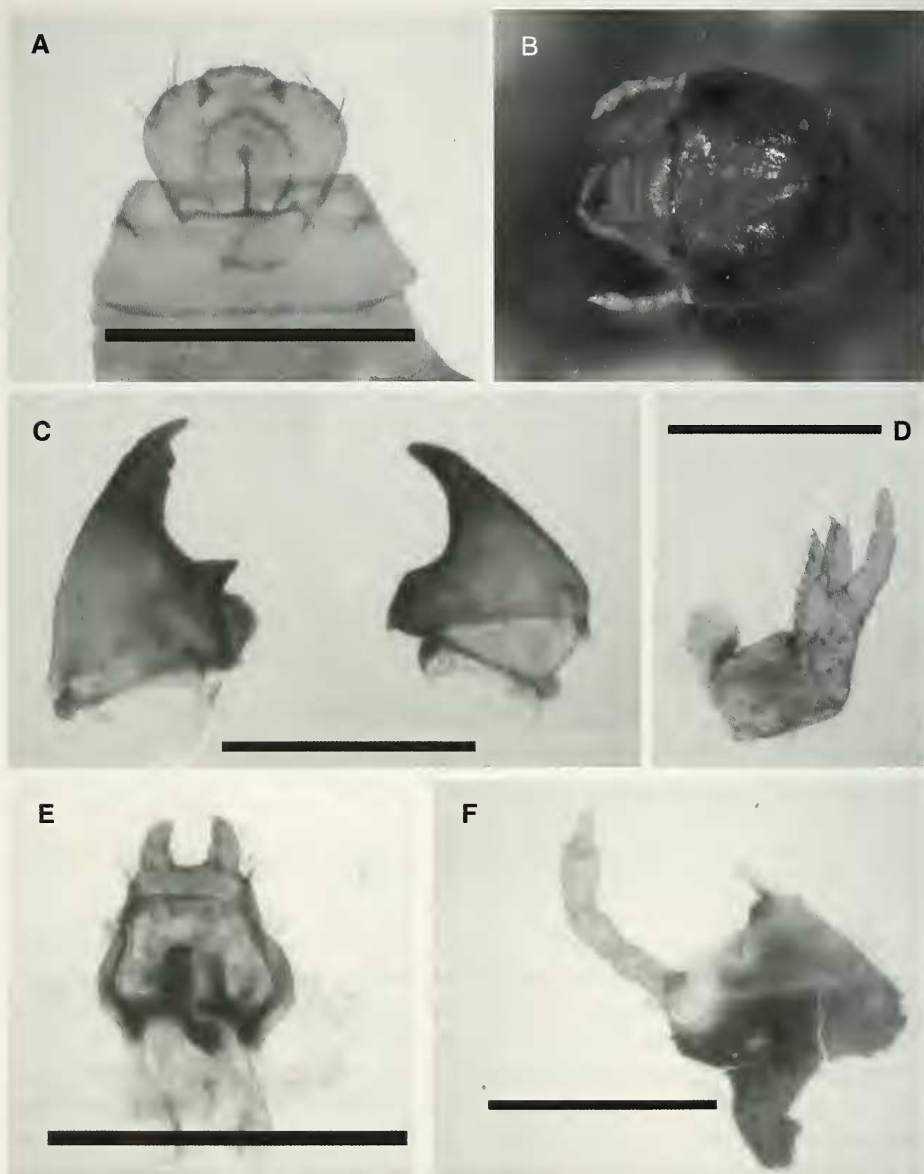


FIG. 4

(A) Epipharynx. (B) Head. (C) Left and right mandibles. (D) Right maxilla. (F) Hypopharynx. (G) Left antenna. Scale bar length = 0.5 mm.

Antennae (Fig. 4F). Length 0.47 mm; antennal base length 0.05 mm; I antennomere length 0.14 mm; II antennomere length 0.10 mm; III antennomere length 0.15 mm, width 0.07 mm; IV antennomere length 0.08 mm. Antennal segments 1-2 of equal length, segment 3 expanded carrying 5-6 subapical setae, the obliquely inserted



FIG. 5
Larva in dung pad.

segment 4 and a thick, conical, little sclerotized sensillum. The antennal segment 4 is truncated at apex, with not-sclerotized area, microsensilla and narrow seta.

Legs (Fig. 3B, C, D). Foreleg: length coxa 0.30 mm, trochanter 0.16 mm, femur 0.20 mm, tibia 0.21 mm, claw 0.09 mm. Middleleg: length coxa 0.42 mm, trochanter 0.24 mm, femur 0.25 mm, tibia 0.25 mm, claw 0.09 mm. Hindleg: length coxa 0.44 mm, trochanter 0.21 mm, femur 0.26 mm, tibia 0.26 mm, claw 0.09 mm. All the legs nearly the same in length, well-developed. Fore coxa thick, shorter than the others. Fore trochanter curved, with placoid sensilla, and at least 6 setae, one very elongate near femur. Femora almost same in length, enlarged at apex, carrying subapically a crown of 6 setae, and 4 setae scattered. Tibia-tarsus complex subcylindrical, with a crown of 6 setae circum-apically, and 7 longer and scattered setae. Claws elongate, with two thick, close, short setae ventrally near the base. Pubescence yellowish ochreous, for the most mixed up, scattered on the whole surface except for the apical areas.

Raster (Fig. 3E). Length 0.57, width 0.76. Recumbent and curved 60-70 setae, caudally directed. Ventral side of X abdominal segment carrying basally and laterally more elongate barbula.

X abdominal segment (Fig. 3F). Width 1.56 mm; Total length 1.60 mm; Lobe I length 0.62 mm; Lobe II length 0.77 mm. Transversal, slightly curvilinear anal fissure, between two flat lobes, the dorsal one transversal and curvilinear, the ventral one deeply notched in the middle.

CONCLUSIVE REMARKS

The species was collected in fifteen localities of altitude between 1,500 and 2,000 m, and in 2005-6 was very abundant in August in Val Ferret (Tab. 1). Observations on the 30 adults reared in laboratory evinced that they make use of the dung mass both for feeding and egg deposition. They lay eggs directly in the dung, without any parental care, as the majority of Aphodiini (Bornemissza, 1976, Barbero *et al.*, 2001, Borghesio & Palestini 2002a, 2002b).

The larvae were collected in dung intermediate-endocoprid zone (dwellers) in small, subspheric, not-organized niches, characterized by unsteady dimensions fitting larval size (Fig. 5). The niches were generate and maintained by the incessant movement of the same larvae, that are active in 1st and 2nd instar and slow more and more in 3rd instar approaching the pupal stage. As reported by Dellacasa & Dellacasa (2006), the species winters as 3rd instar larva.

Since this is the first *Agoliinus* species on which observations of reproductive behaviour and description of preimaginal stages were made, we cannot compare at present the larval morphology variation within the genus. Besides, we noticed that the *A. satyrus* larvae do not show peculiar characters in respect to the other known aphodiinae larvae. The described pattern falls within a very conservative model, as can be found in larval stages of a number of species of other genera (Palestrini & Barbero, 1992, Barbero & Palestini, 1995, Barbero *et al.*, 2001).

Notably, once the aphodioid larval pattern is adopted it did not greatly differ in distinct species. It seems that – from an evolutionary biology point of view – diversification in larval stage was not the chosen strategy, but it is maintained a pattern that reveal itself effective for a rapid development.

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